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Domain structure evolution in (111)-cut rhombohedral PMN-PT single crystals during polarization reversal

A.D. Ushakov[1], A.A. Esin[1], A.R. Akhmatkhanov[1], Q. Hu[2], X. Liu[1,2], Y. Zhao[1,2], A.A. Andreev[1], X. Wei[2], V.Ya. Shur[1]

[1] *School of Natural Sciences and Mathematics, Ural Federal University, 620000, Ekaterinburg, Russia andrey.ushakov@urfu.ru*

[2] *Electronic Materials Research Laboratory, Key Laboratory of the Ministry of Education & International Center for Dielectric Research, Xi'an Jiaotong University, 710049, Xi'an, China*

Lead magnesium niobate-lead titanate (1-*x*)Pb($Mg_{1/3}Nb_{2/3}$)O_3-*x*$PbTiO_3$ (PMN-PT) solid solution attracts a great attention due to its prominent piezoelectric properties used for actuator, sensor, transducer and energy harvesting applications [1]. Moreover, PMN-PT is considered as a potential candidate for non-linear optical and photonic devices. It implies that deep understanding of the physical fundamentals of domain structure evolution and polarization reversal process is essential for the creation of domain patterns for promising applications in this material.

In the present work, we studied the domain kinetics during polarization reversal in rhombohedral [111]-oriented PMN-PT crystal by *in situ* optical microscopy domain visualization and interferometric profilometry at different stages of switching accompanied by analysis of the switching current data (Fig. 1). It allowed us to distinguish different domain types from the revealed optical contrasts and to define the domain structure evolution stages from initial ***c***↑-domain state with small number of ***a***↑-domains and *2**a**-CDW*: (I) nucleation and growth of ***a***↑-domains and *2**a**-CDW*; (II) nucleation and growth of ***c***↓-domains (with opposite direction of spontaneous polarization). The effect of light scattering on *2**a**-CDW* with field-controlled density was revealed. The estimated "optical current" [3] obtained by analysis of the optical images correlated with the switching current data in both cases. The undesirable effect of the partial backswitching during electric field decrease was attributed to the clamped switching conditions.

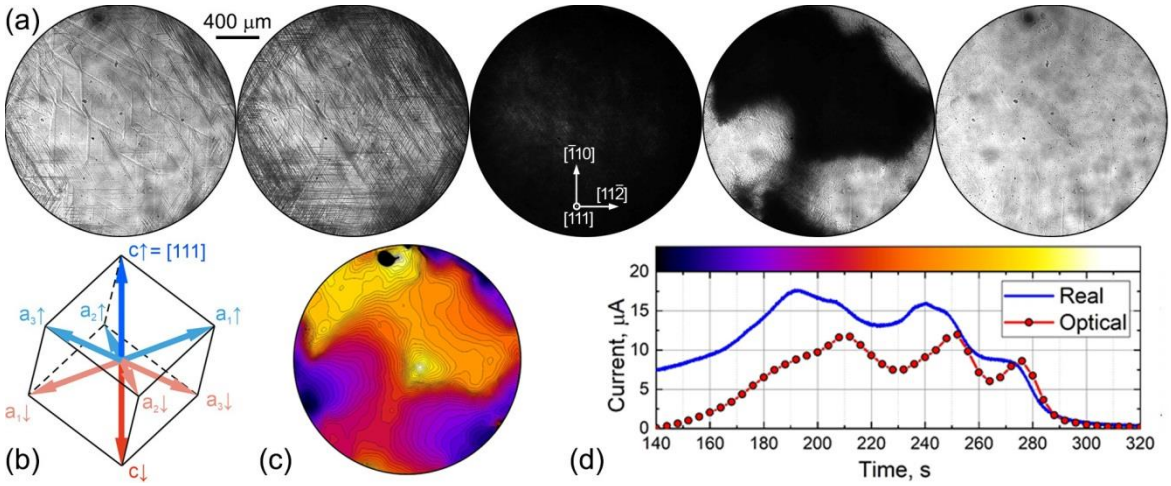

Figure 1. (a) Optical images of instantaneous domain states during polarization reversal in (111)-cut rhombohedral PMN-PT single crystal. (b) Polarization directions for [111]-oriented pseudocubic cell. (c) Kinetic map and (d) the real switching and optical currents.

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1. E. Sun, W. Cao, *Prog. Mater. Sci.* **65**, 124 (2014).
2. A.D. Ushakov, A.A. Esin, A.R. Akhmatkhanov et al., *Appl. Phys. Lett.* **113**, 112902 (2018).
3. V.Ya. Shur, E.V. Nikolaeva, E.I. Shishkin, et al., *Appl. Phys. Lett.* **79**, 3146 (2001).